UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF THE CASCADING MODULE FOR HYDRO ENERGY DECISION SUPPORT SYSTEM (HEDSS) FOR TEMENGOR-BERSIAK-KENERING POWER PLANTS

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ABSTRACT

Reservoir operation has generate electric power for Tenaga Nasional Berhad for a few decades now, yet the solution to ease daily operation in making decision pertaining to the power optimization remain problematic. Despite development of new techniques, implicit stochastic optimization models using linear programming (LP) remain one of the most readily applicable to the analysis of complex system. However, optimization calculation using manual approach consumes ample of time. This dissertation presents the development of an automation system (HEDSS) to ease the optimization calculation. The scope however is limited to the cascading module. The proposed method is implemented using Waterfall model of System Development Life Cycle (SDLC). The power plants chosen were Temengor, Kenering, Bersia; three cascading reservoirs at Sg.Perak. The method is demonstrated by comparing approach done manually versus automation. The objective function is to minimized the economic cost in hydropower plants operations. A generalized network flow algorithm is used to find the optimal solution.

ACKNOWLEDGEMENTS

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CHAPTER 1

INTRODUCTION

Sungai Perak hydroelectric scheme consists of Temengor, Bersia, Kenering and Chendroh hydro power plants. All of those power plants are situated one after another along the main stream flow of Perak River. Each power plants has its own reservoir or regulating ponds, variable in sizes, ranging from annual to daily storage capability. Except for Chendroh, all of those plants are commissioned at the end of 70's or early of 80's. Whilst history Chendroh hydroelectric scheme extended way back to 30's.

Temengor Hydroelectric reservoir is the main reservoir of Perak River Cascade. It is located on the upper most of the system. It follows by Bersia pond; located at about 20km downstream of Temengor reservoir. Next, Kenering pond; located at about 45 km downstream to Bersia pond. Cendroh pond is the last pond of the system.

Figure 1.1 illustrated River of Perak cascade consist of Temengor-Bersia-Kenering whilst Table1.1 illustrates some of the important design characteristics of the system. Note that, Chendroh hydro scheme will not be included in the paper.

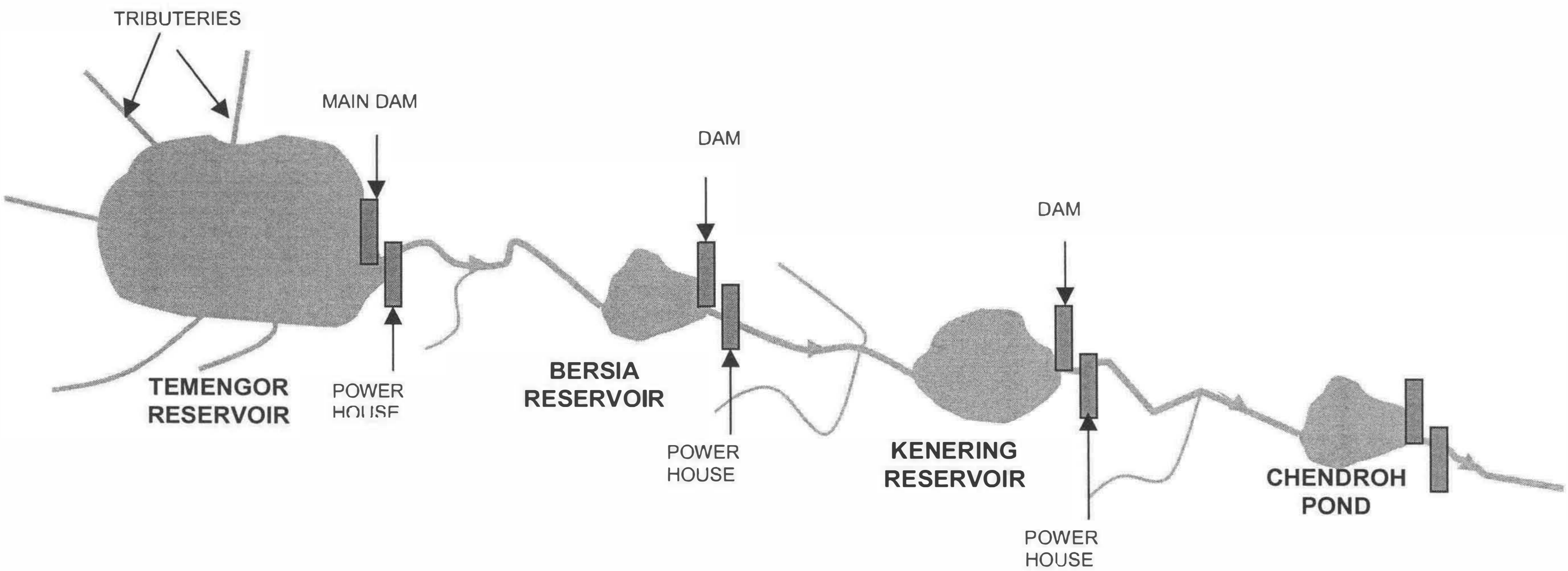
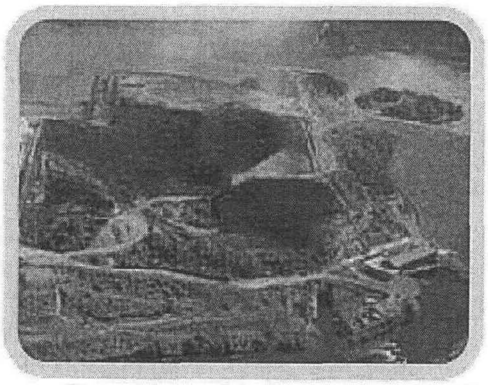


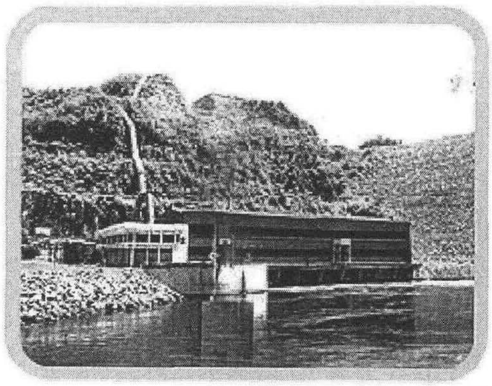
Figure 1.1: Schematic Diagram for Sungai Perak Cascade Scheme consists of Temengor-Bersia-Kenering and Chendroh hydroelectric power plant.

Temengor Hydro-Electric Power Station

The Temengor Hydro-Electric Power Station is located in the north-western state of Perak, at a site on the Upper Perak River immediately downstream of its confluence with the tributary Temengor River. A 127 meters (416 feet) maximum height high rockfill dam with a central impervious core creates a reservoir 80 kilometers (50 miles) long covering an area of 15,000 hectare (37,000 acres).

With a catchments area of 340,000 hectare (1,310 square miles), the dam impounds 6,050,000,000 cu. meters (4,910,000 acre feet) of water at normal full supply level, of which 1,270,000,000 cu. meters (1,030,000 acre feet) is utilized as live storage. The crest level of the dam provides sufficient freeboard for an additional 850,000,000 cu. meters (690,000 acre feet) of flood storage capacity, which together with a free overflow chute spillway, will regulate flow past the dam during the flood period.

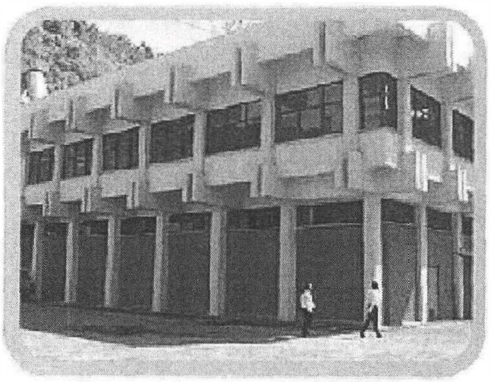

The aerial view of the Temengor Power Station


Temengor Power Station

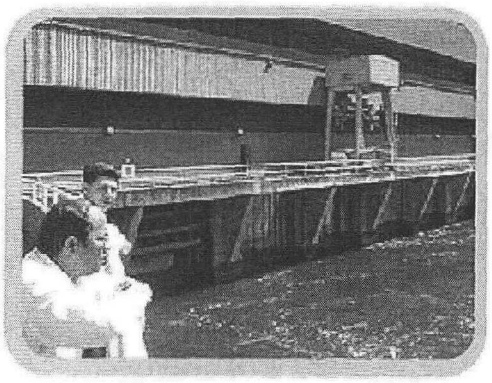
Twin tunnels nine meters (30) in diameter were constructed to divert the river flow during construction of the dam and generating facilities. Two 2.3 m (90 inches) hollow cone valves and butterfly valves were provided in one of the diversions tunnels to discharge riparian flows and regulate water levels upstream during the filling of the reservoir. The generation facilities consist of four units with a total installed capacity of 348 MW.

Power Station

The Power Station has four generating units, made up of Francis type turbines vertically coupled to air-cooled generators. The units are contained in a conventional building which also contains control apparatus, a repair bay, and an office building with a control room, workshop, storage and office facilities.



The front view of the Temengor Power Station



The Tail race

The turbines each has an output of 90,000 kW at a rated head of 101 m (330 feet) and the generators are rated 105HVA/0.9pf/50Hz. Each generators output feeds a three phase 50Hz 63/84/105 MVA oil-cooled transformers, through the switchyard and then by 275 kV transmission lines, the system network.

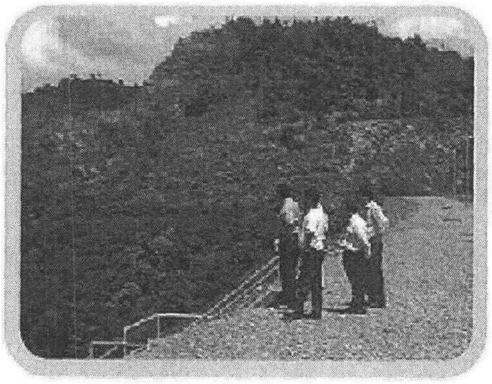
Dam

The Temengor Main Dam was constructed of approximately 7,000,000 cubic meters (9,000,000 cu. yds.) of fill material over a period of two and a half years.

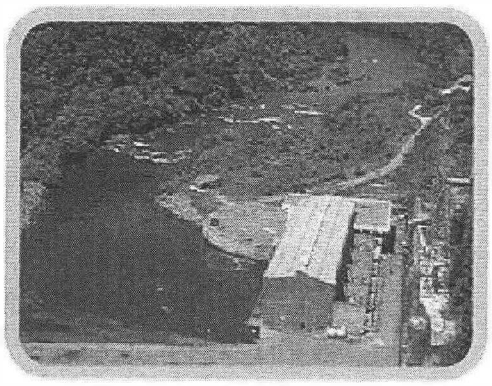
The core material of weathered granite (clayed sand) came from a borrow area located eight kilometers downstream of the site. It was placed in layers not exceeding 15 cm (six inches) after compaction using smooth-faced vibratory rollers. The surface was crowned throughout the placing of the core material to facilitate the shedding of water during periods of rainfall. The rockfill for the dam, obtained from a borrow area at the top of the ridge adjacent to the right abutment of the dam, is a greywacke which also extends throughout the entire foundation area. This material is generally exposed throughout the flood plain of the river and is overlain with a thin mantle of overburden and weathered rock on the abutment flanks.

Rock from the borrow area was processed through grizzlies to produce three size fractions to be placed with the zones of the dam. The fine fractions were placed in layers not exceeding 15 cm (six inches) after compaction and the medium fraction were placed in layers not exceeding 45 cm (18 inches). Both the fine and medium fractions were compacted using smooth-faced vibratory rollers. The oversize fraction was placed in layers not exceeding one meter (three feet) with no further compaction other than that achieved during spreading.

Following the construction of the low level upstream and downstream cofferdams, the toe of the dam was raised 47 meters (154 feet) to provide sufficient storage to pass the construction flood through the diversion works during the flood period. This stage one dam has a sloped upstream membrane of the same material as the impervious core of the main structure.



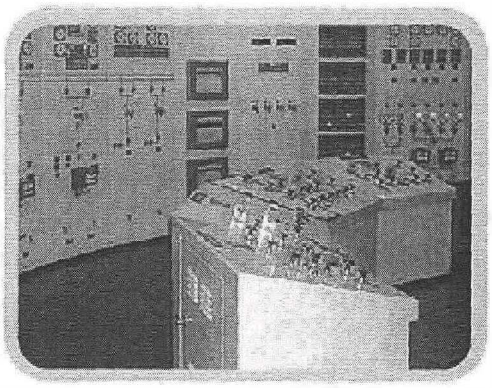
The top view of the Temengor Power Station



The top view of the Temengor Power Station

Closure Structures

Closure structures were constructed in a saddle area located on the right bank of the river.In the saddle area, a series of steeply dipping faults occur where the foundation rock is more closely jointed or fractured and the depth of weathering is greater than that normally found in the site area. A low closure dam, together with blanket treatment of the slopes, has been constructed to provide rim competence at this location. A drainage tunnel downstream of the closure structure was built to aid in maintaining slope stability.

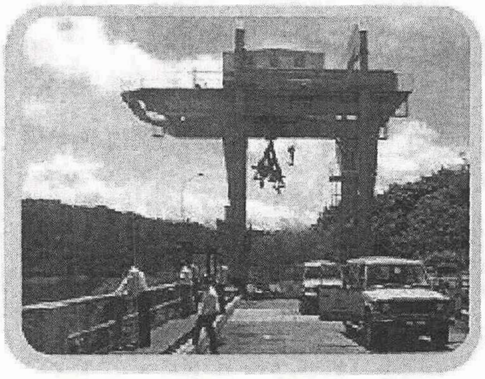


Station Control Room

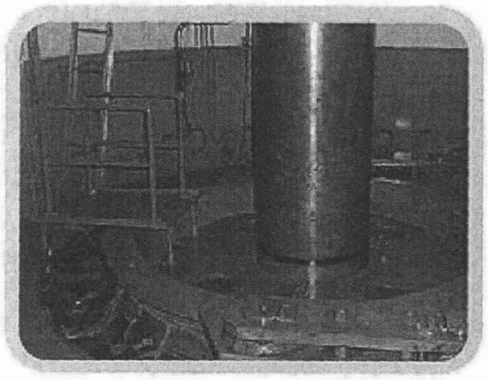
Tunnels

Two diversion tunnel nine meters (30 feet) in diameter were constructed to divert the river during the construction period.

Four power tunnels six meters (19 feet) in diameter supply the generating units. The power tunnels are concrete lined, with increasing reinforcement and finally a steel lining backed by concrete at the outlet portals of the tunnels is provided. A 2.5 m (8 feet) diameter drainage tunnel runs parallel to the power tunnels between the tunnels and the valley face, relief holes being drilled to intercept any leakage from the power tunnels.



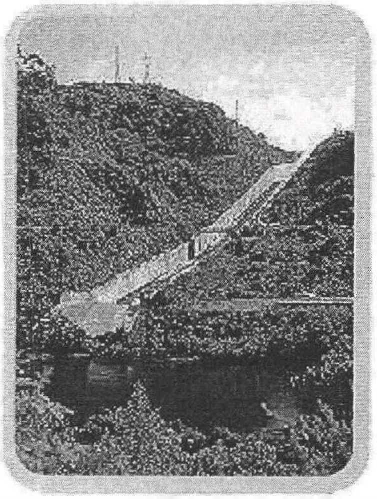
Station Intake

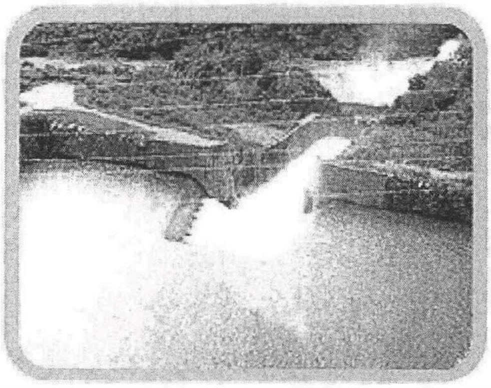


Turbine Pit Area

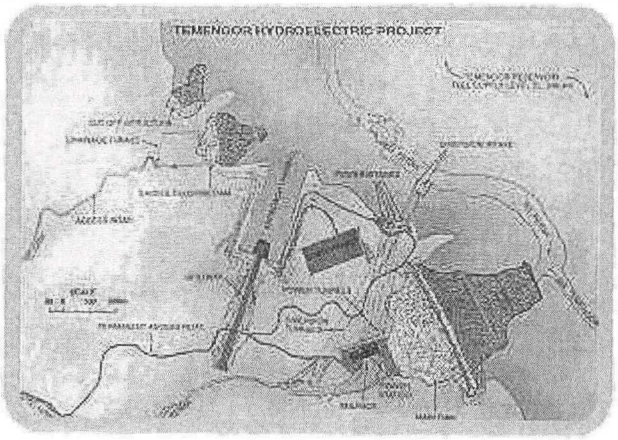
Spillway

The spillway is located on the eight so that its entrance channels extends through the ridge forming the right abutment. Excavated rocks from the entrance channel were used as fill for the dam. The spillway is made up of a U-shaped free overflow structure extending through the rock plug across the downstream end of the entrance channel with a transition to a parallel-sided concrete chute extending down the valley bank. The chute terminates in a flip bucket designed to disperse the discharge as much as possible in order to reduce the impact of the water on the bed of the river. Model studies were used to determine the size and shape of the structure.

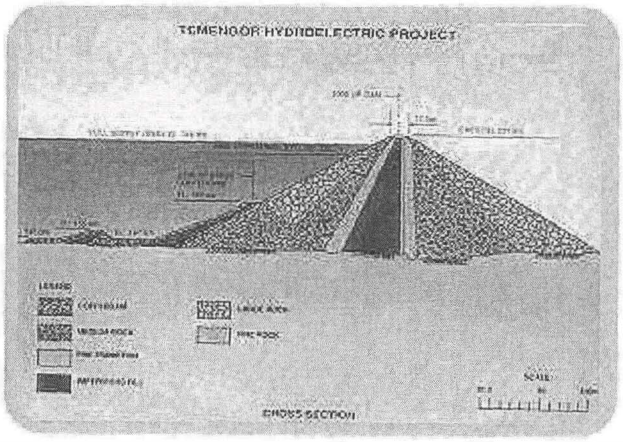




Free-Overflow Spillway



The diagram of Temengor Power Station



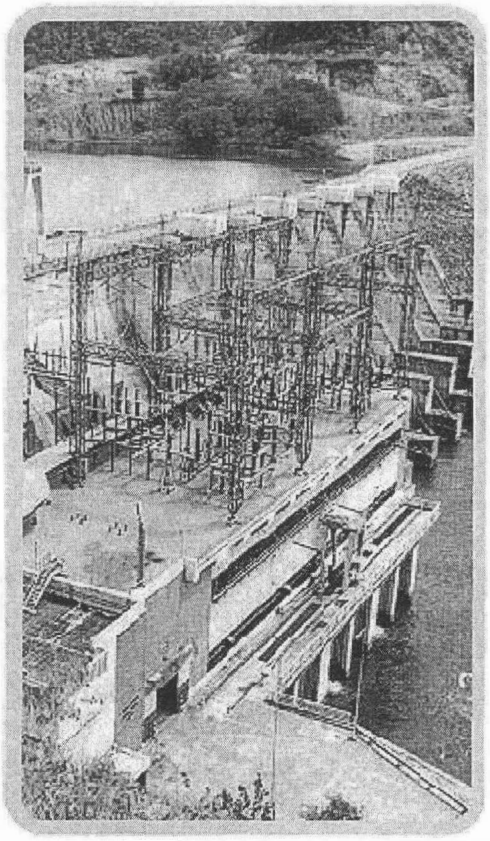
Cross section of Temengor Dam

Bersia Power Station

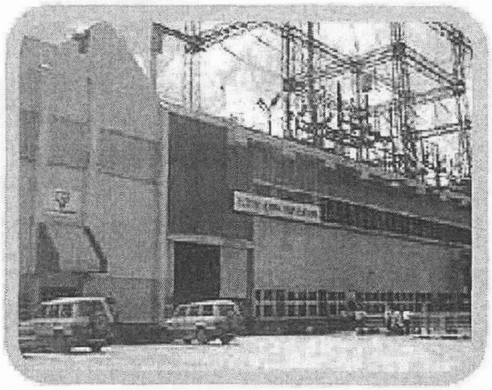
The Sultan Azlan Shah Bersia Hydroelectric Power Station is located in the North Western State of Perak, Peninsular Malaysia at a site of the Upper Perak River approximately 20 km downstream of the Temengor Hydroelectric Project and approximately 16 km by road from town of Gerik.

The construction of a 33 meter high concrete gravity dam has created a reservoir approximately 5.7 sq. km area at full supply level. With catchments area of 3,560 sq. km, the dam impounds 70, 000, 000 cu. meters of water at normal full supply of which 58, 000, 000 cu. meters of water is utilized as active storage. A spillway comprising 4 radial gated free discharge rollaway channels regulates excess flow pass the dam Conventional two stages type diversion works were utilized whereby part of the river channel was first cofferdam med so that construction could be carried out within the area, whilst the river flowed through the remaining channel.

Adequate diversion ports were provided in the central bulked head and one spillway bay of the first stage construction such that during the second stage, water could be diverted through the port enabling the remaining construction to be carried out and also providing riparian flows to down stream users. The generating facilities consist of three units with the total installed capacity of 72 megawatts.



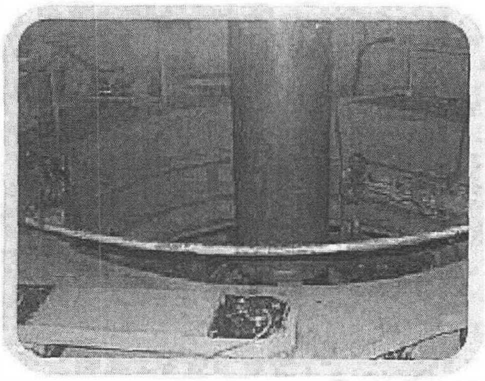
Sultan Azlan Shah Hydro Electric
Power Station, Bersia



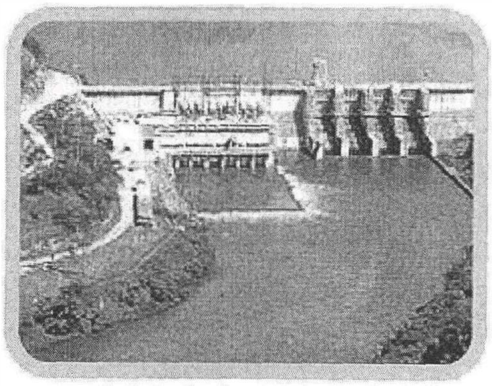
Bersia Power Station

cavitations aeration lips on the surface of the rollway and corresponding aerations ducts in the piers the aerate the flow entering the trajectory bucket, to reduce the risk of cavitations in the trajectory bucket. Spillway piers are of reinforce concrete. A conventional free discharge trajectory, bucket is provided on each railway.

As the Bersia Power station will be opened remotely, sensors have been provided to detect the start of the fire at any location in the power station. The generator fire protection is CO2 type, the transformer protection is of sprinkler type, whilst Halon protection has been specified for the plant in the equipment rooms such as telecommunications room, control room, battery room, cable spreading room, etc.



Turbine Pit Area



A dissipating basin below the Bersia Power Station prevents the turbine discharge from eroding the stream bed.